

What is claimed is:

1. A driving apparatus comprising:
 - a driving unit having a plurality of displacement elements;
 - a synthesizing member connected to a tip end of each of the plurality of displacement elements, the synthesizing member being in pressure contact with a driven member;
 - a base member supporting base ends of the plurality of displacement elements;
 - a spring member attached to the base member biasing the synthesizing member onto the driven member;
 - a drive signal output unit outputting drive signals to each of the plurality of displacement elements causing the synthesizing member to perform a specific motion, the driven member being driven in a prescribed direction by the synthesizing member performing the specific motion; and
 - a regulating member regulating a displacement of the driving unit, the regulating member facing the base member opposite from the driven member at a prescribed distance from the base member.
2. A driving apparatus according to claim 1, wherein the prescribed distance approximately equals or exceeds an amplitude of oscillation of the driving unit caused by a displacement of the plurality of displacement elements.
3. A driving apparatus according to claim 2, wherein the prescribed distance approximately equals or exceeds a sum of the amplitude of oscillation of the driving unit caused by the displacement of the plurality of the displacement elements and a length that accommodates a change in a contact position of the driven member.

4. A driving apparatus according to claim 2, wherein the spring member applies a force to the driving unit in a direction perpendicular to a contact surface of the synthesizing member and driven member, and the regulating member maintains the driving unit at an upstream position relative to the prescribed direction of driving.

5. A driving apparatus according to claim 1, wherein the specific motion is reciprocating.

6. A driving apparatus according to claim 5, wherein the specific motion is one of circular, elliptical, and linear.

7. A driving apparatus according to claim 1, wherein the spring member applies a force to the driving unit in a direction perpendicular to a contact surface of the synthesizing member and driven member, and the regulating member maintains the driving unit at an upstream position relative to the prescribed direction of driving.

8. A driving apparatus according to claim 1, wherein the plurality of displacement elements have a truss type structure.

9. A driving apparatus according to claim 1, wherein the plurality of displacement elements are piezoelectric elements made from PZT.

10. A driving apparatus comprising:
a driving unit having a plurality of displacement elements;
a synthesizing member connected to a tip end of each of the plurality of displacement

elements, the synthesizing member being in pressure contact with a driven member;

a base member supporting base ends of the plurality of displacement elements;

a spring member attached to the base member biasing the synthesizing member onto the driven member;

a drive signal output unit outputting drive signals to each of the plurality of displacement elements causing the synthesizing member to perform a specific motion, the driven member being driven in a prescribed direction by the synthesizing member performing the specific motion; and

a regulating member regulating a displacement of said driving unit, the regulating member being located at a position facing the base member opposite from the driven member, the spring member applying a force to the driving unit in a direction perpendicular to a contact surface of the synthesizing member and driven member, and the regulating member maintaining the driving unit at an upstream position relative to the direction of driving.

11. A driving apparatus according to claim 10, wherein the regulating member further comprises a support member rotatably supporting the driving unit and acting as a fulcrum.

12. A driving apparatus according to claim 10, wherein the specific motion is reciprocating.

13. A driving apparatus according to claim 12, wherein the specific motion is one of circular, elliptical, and linear.

14. A driving apparatus according to claim 10, wherein the plurality of displacement elements have a truss type structure.

15. A driving apparatus according to claim 10, wherein the plurality of displacement elements are piezoelectric elements made from PZT.

16. A method for driving a driven member using a driving unit having a plurality of displacement elements, a synthesizing member connected to a tip end of each of the plurality of displacement elements, and a base member supporting base ends of the plurality of displacement elements, the method comprising:

biasing the synthesizing member into contact with the driven member;

outputting drive signals to each of the plurality of displacement elements;

moving the synthesizing member in a specific motion;

driving the driven member in a prescribed direction based on the specific motion performed by the synthesizing member; and

regulating a displacement of the driving unit.

17. A method for driving according to claim 16, further comprising accommodating a change in a contact position of the driven member.

18. A method of driving according to claim 16, further comprising applying a force to the driving unit in a direction perpendicular to a contact surface of the synthesizing member and driven member, and maintaining the driving unit at an upstream position relative to the prescribed direction of driving.

19. A method of driving according to claim 16, further comprising moving the synthesizing member in a reciprocating motion.

20. A method of driving according to claim 16, further comprising moving the synthesizing member in one of a circular motion, an elliptical motion, and a linear motion.

Approved for release